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СЕКЦІЯ 10. МАТЕМАТИЧНІ МЕТОДИ В ЕКОНОМІЦІ

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ECONOMIC AND MATHEMATICAL METHODS FOR ASSESSING AND MANAGING BANK FINANCIAL SECURITY

The need to improve the financial stability of banks is motivated by the necessity to ensure the sustainable development of the banking system as a whole, as well as to increase the efficiency and reliability of individual banking institutions. Despite a significant number of scientific studies, the issues of managing banks' financial stability remain insufficiently explored.

In particular, this concerns the processes of diagnosing and assessing the level of a bank's financial security, as well as the use of financial instruments to mitigate negative effects [1–4]. Existing methodologies are primarily focused on individual banking institutions, taking into account their specific characteristics, and do not provide a framework for all market participants, based on publicly available information, that would allow for sufficient adaptability to specialization, changing conditions, and operational specifics. Consequently, research into theoretical and methodological approaches to ensuring banks' financial security from the perspective of transparency and open data is becoming particularly relevant.

Factors such as improving the corporate governance system, which involves increasing the transparency of the bank's activities and the openness of information to interested parties, strengthening the effectiveness of risk management, and optimizing interaction between the bank's management bodies, its shareholders, and other stakeholders play a significant role in ensuring and enhancing the bank's financial security. The combined effect of these factors creates the conditions for increasing the effectiveness of management decisions, minimizing the negative impact of risks, and, as a result, achieving the strategic goal of improving the effectiveness of the bank's financial security system in an unstable economic environment.



The development and further improvement of effective risk management systems by banks, as well as their gradual alignment with the requirements and recommendations of international standards, contribute to reducing the overall risk level in the banking sector and limiting banks' excessive risk-taking. At the same time, measures aimed at aligning the growth dynamics of the banking sector's assets with the pace of the country's economic development can have a positive impact on minimizing the risks of banking activities. Such alignment prevents the formation of imbalances, enhances the stability of the banking system, and creates conditions for its sustainable development in the long term.

An important part of the security system is the creation and implementation of modern engineering and technical means for protecting facilities, including the physical protection of premises, equipment, and material assets, as well as comprehensive access control, alarm, and video surveillance systems. In addition, ensuring the preservation of material assets through reliable procedures for their accounting, transportation, and insurance protection is crucial, as it minimizes the risk of loss and enhances the overall level of security of the institution or enterprise.

Therefore, the plan should be based on detailed information about the organization's structure and functions, allowing for a clear definition of responsibilities and the distribution of duties among its departments. It is important to include information on the resources and funds required to ensure uninterrupted operation, as well as an assessment of potential losses in the event of an inability to perform core operations. The plan should also list individuals responsible for crisis management, specifying their powers and duties, and describe the procedures and sequence of actions they will undertake to respond effectively to emergency situations. This approach ensures consistency, predictability, and promptness of action in the face of risk or crisis scenarios, contributing to the organization's resilience and security.

To effectively structure the process of plan development, it is necessary to apply an appropriate methodology that takes into account all factors ensuring business continuity.

The methodology consists of a series of stages and steps that collectively represent the components of the project life cycle for developing a business continuity plan for the bank. This approach ensures a systematic and comprehensive analysis of all aspects of the bank's operations, enables the timely identification of risks, and facilitates the implementation of effective measures to maintain the institution's operational stability.

The planning of the activities of the bank under review is based on key factors, including the quality of services provided, operational efficiency, and the organization's development potential. To a large extent, these objectives are achieved through the technologies employed by the bank, which optimize processes, enhance productivity, and contribute to the stability of the institution's operations.



Therefore, it is crucial that, when identifying critical areas of the bank's activities, their dependence on technological components and the specifics of organizational processes is taken into account. In the past, contingency plans were usually limited to assessing risks related solely to computer equipment, which represents a rather narrow approach and does not allow for an adequate response to all potential threats. To ensure the uninterrupted operation of the bank, it is necessary to consider a comprehensive set of interrelated external and internal factors, including not only technological aspects but also manual methods of accounting, information processing and transmission, organizational procedures, human resources, and interdepartmental interaction.

An extremely important element of effective planning is the detailed consideration of all aspects and the step-by-step development of each individual component of the plan. This enables the creation of a structured, adaptive, and reliable framework for ensuring the continuity of the bank's operations, taking into account potential changes in the external environment, internal processes, and organizational resources. Such an approach contributes to enhancing the stability of the bank's operations, reducing the likelihood of losses associated with technical, organizational, and human risks, and ensuring effective long-term crisis management.

The bank's financial security system represents an organized set of interrelated and coordinated tasks and functions, in accordance with the principles of financial security. It provides a systematic approach to the timely identification, assessment, and monitoring of potential external and internal threats, as well as the implementation of measures to prevent or mitigate them. As a result, the system contributes to the stability of the bank's operations, the protection of its assets and resources, the minimization of financial risks, and the reliability of management decisions under various operational conditions.

The formation of a bank's financial security system is based on adherence to a set of key principles. These include the systematic collection, organization, and comprehensive analysis of data on the financial and economic activities of the banking institution, as well as the effectiveness of its management and marketing processes, which ensures an objective assessment of the bank's condition. Furthermore, the application of non-formal analytical methods enhances the reliability and validity of the results obtained and facilitates more accurate and well-founded managerial decisions. It is also essential to treat information as a strategic resource of the bank, taking into account the specifics of its management, protection, and utilization in the processes of planning and ensuring financial security, thereby creating the foundation for the institution's stability and sustainable development.

The enhancement of the bank's financial security system is achieved through the implementation of measures aimed at ensuring the reliable protection of assets and the effective execution of the institution's core functions.



Based on the analysis of existing practices for evaluating bank performance, considering their impact on financial security, it can be concluded that there is a need to develop and implement an effective mechanism for establishing a financial security system that ensures the timely identification of risks, their mitigation, and the stable operation of banking institutions.

Such a mechanism represents a set of processes and states within the bank's financial security system that facilitate the implementation of its formation stages through the application of various methods, tools, and instruments. It constitutes a multi-model task, as a complex and dynamic financial security system cannot be fully characterized by a single, indivisible indicator.

Given the multifactorial nature of a bank's financial security system, the use of economic and mathematical methods is advisable, particularly multi-criteria analysis, composite indicators, and normalization and weighting techniques. These methods enable a quantitative assessment of the level of financial security, the identification of critical areas, and the substantiation of management decisions.

In this context, economic and mathematical methods act as a tool for integrating heterogeneous indicators into a unified analytical framework. Their application allows not only for the quantitative evaluation of the current level of a bank's financial security but also for modeling potential trajectories of its changes under the influence of individual factors, which is particularly important in an unstable economic environment.

On one hand, the mathematical framework must remain sufficiently simple and practical to allow for the effective analysis and synthesis of bank security strategies; on the other hand, it must be versatile and accurately reflect real processes and interrelationships. At present, there is no single, universally accepted mechanism for establishing a bank's financial security system, as ensuring financial security is a continuous, complex, and multifactorial process that involves the interaction of numerous internal and external factors and requires a comprehensive approach to risk management.

Based on the analysis and synthesis of research on methodological approaches to forming a bank's financial security system, it is proposed to decompose the system into three levels: formation, control, and management. Unlike existing approaches, this decomposition enables the creation of an organizational structure for the financial security system that ensures more efficient use of available resources and allows for rapid adaptation to current tasks and changing operational conditions. Each level of the system can be formalized using appropriate mathematical models, allowing for a quantitative assessment of the impact of individual parameters on the overall level of the bank's financial security.

Structuring a bank's financial security system involves dividing it into distinct components (decomposition approach) and defining the evaluation criteria and conditions for each component. The process of "breaking down" the system should



continue until the minimal set of parameters directly affecting the functioning of each individual component is identified. Once the parameters for each component are determined, they are reconciled with the parameters of other elements at the same system level, allowing for the assessment of mutual influences and ensuring the balanced operation of the entire bank's financial security system.

Modelling, as a tool for implementing financial security policies, is widely employed by banking professionals to assess risks, forecast the consequences of managerial decisions, and optimize resources. The mathematical apparatus in this process must, on the one hand, remain sufficiently simple and constructive to allow for effective analysis and synthesis of bank security strategies, and on the other hand, be versatile and capable of adequately representing real processes and interrelationships within banking operations. The use of mathematical methods in this context enables the formalization of financial security management processes, enhancing the objectivity of assessments and the reliability of forecasts.

The following methods and tools are commonly used for modelling in banks:

- statistical methods – including time series analysis, correlation and regression analysis for risk assessment and financial forecasting;
- simulation modelling – constructing scenarios for event development, evaluating the impact of crisis situations, and conducting stress testing of bank portfolios;
- optimization methods – linear and nonlinear programming for efficient resource allocation and risk minimization;
- discrete process modelling – developing models of bank departments and operational processes to enhance risk management and control over financial activities;
- probability and risk models – constructing models for credit risk, liquidity risk, and market risk using Monte Carlo simulations and value-at-risk (VaR) techniques.

The comprehensive application of these economic and mathematical methods enables the creation of an integrated analytical system for supporting the management of a bank's financial security. The combination of statistical, simulation, and optimization models allows both retrospective analysis and forecasting of potential scenarios, enhancing the bank's adaptability to changes in the external environment and reducing the likelihood of critical financial risks materializing.

By applying these methods, banks are able to model various scenarios, evaluate the potential impact of external and internal threats on financial stability, and make informed management decisions that ensure operational continuity and enhance the effectiveness of the financial security system.

Both domestic and international researchers have accumulated considerable experience in modelling security systems; however, a single, generally accepted approach to modelling has yet to be established. Existing modelling methodologies often lack sufficient predictive capabilities and do not allow for the proactive adjustment of the system's structure prior to the occurrence of adverse events.



General security system models differ in that they allow for the determination and evaluation of the overall characteristics of the system and its processes, in contrast to local and discrete models, which assess individual local or discrete parameters of the system or its processes. The use of general models enables a comprehensive analysis of interrelationships and effective prediction of the security system's dynamics, thereby enhancing the reliability of management decisions in banking practice [5].

Although domestic and foreign researchers have accumulated considerable experience in modelling security systems, there is currently no single, generally accepted approach. Existing modelling methodologies often lack sufficient predictive capabilities and do not allow for the proactive adjustment of the system's structure prior to the occurrence of adverse events.

The general model of a security system can be represented as a three-dimensional structure, with axes formed by interrelated and interdependent vectors: "Security Directions", "Methods of Achievement" and "Costs of Achievement". Entities within the model are characterized by attributes and types, which are connected through relationships. The relationship between entity types reflects their actual or potential interactions, while the attribute that uniquely identifies a specific entity type is referred to as a key.

As is well known, each banking institution faces a wide range of potential threats, the likelihood of which varies considerably. Due to limited banking resources, it is impossible to prevent or counteract all types of threats. Moreover, not all existing threats are equally significant for the bank, making it particularly important to identify those that have the least impact on operational quality and sustainability criteria. Assessing the probability and significance of threats is best carried out using probabilistic and statistical methods, which allows for their ranking and the identification of priority areas for management intervention.

Banking activities encompass nearly all spheres of economic and social life, and the number of assets requiring protection depends on the institution's specialization and scale of operations. Consequently, effective financial security management necessitates a differentiated approach to threat assessment and the prioritization of preventive measures.

In general, the objects of protection in a bank can be classified into several main groups: financial resources – including domestic and foreign currency, the bank's commercial operations and transactions, valuables, and financial documents; bank personnel – such as management and senior executives, individuals with access to banking secrets, and other employees of the institution; material resources – including buildings, storage facilities, equipment, vehicles, and IT systems; and restricted-access information resources – comprising data that constitute banking and commercial secrets, as well as other confidential bank information [2].



At the level of the banking system as a whole, economic and mathematical methods play a key role in forming the analytical foundation for macroprudential regulation. Their application enables a comprehensive assessment of banks' financial stability, identification of systemic risks, modelling of the consequences of regulatory decisions, and forecasting the impact of external shocks on the stability of the banking sector [6]. This, in turn, facilitates timely preventive management decisions and enhances the effectiveness of supervision over banking institutions.

Thus, to ensure a bank's financial stability, its activities must be subject to comprehensive and rigorous control. The National Bank of Ukraine exercises external oversight of banks' operations through the implementation of banking regulation and supervision functions, based on the Core Principles for Effective Banking Supervision developed by the Basel Committee on Banking Supervision. The effectiveness of such control and supervision is significantly enhanced through the application of economic and mathematical methods for analysis and forecasting, which enable the timely identification of risks, the assessment of banks' financial stability, and the prevention of systemic threats within the banking sector.

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